Energy System Evaluation method

Jan. 2004

Tokyo University of Agriculture and Technology

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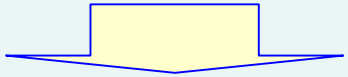
The background of the simulator development

There is a tendency that energy consumption of a commercial sector in a city increases.

Conventionally, energy saving measures have been implemented to each apparatus and building.



From now on, the energy saving and the environment measure as the area for more than one building are necessary. Moreover, the introduction of a system which utilizes renewable energy, such as PV and wind power, is expected.

For that purpose, the tool which can evaluate the energy system of an area by high accuracy quantitatively is needed.

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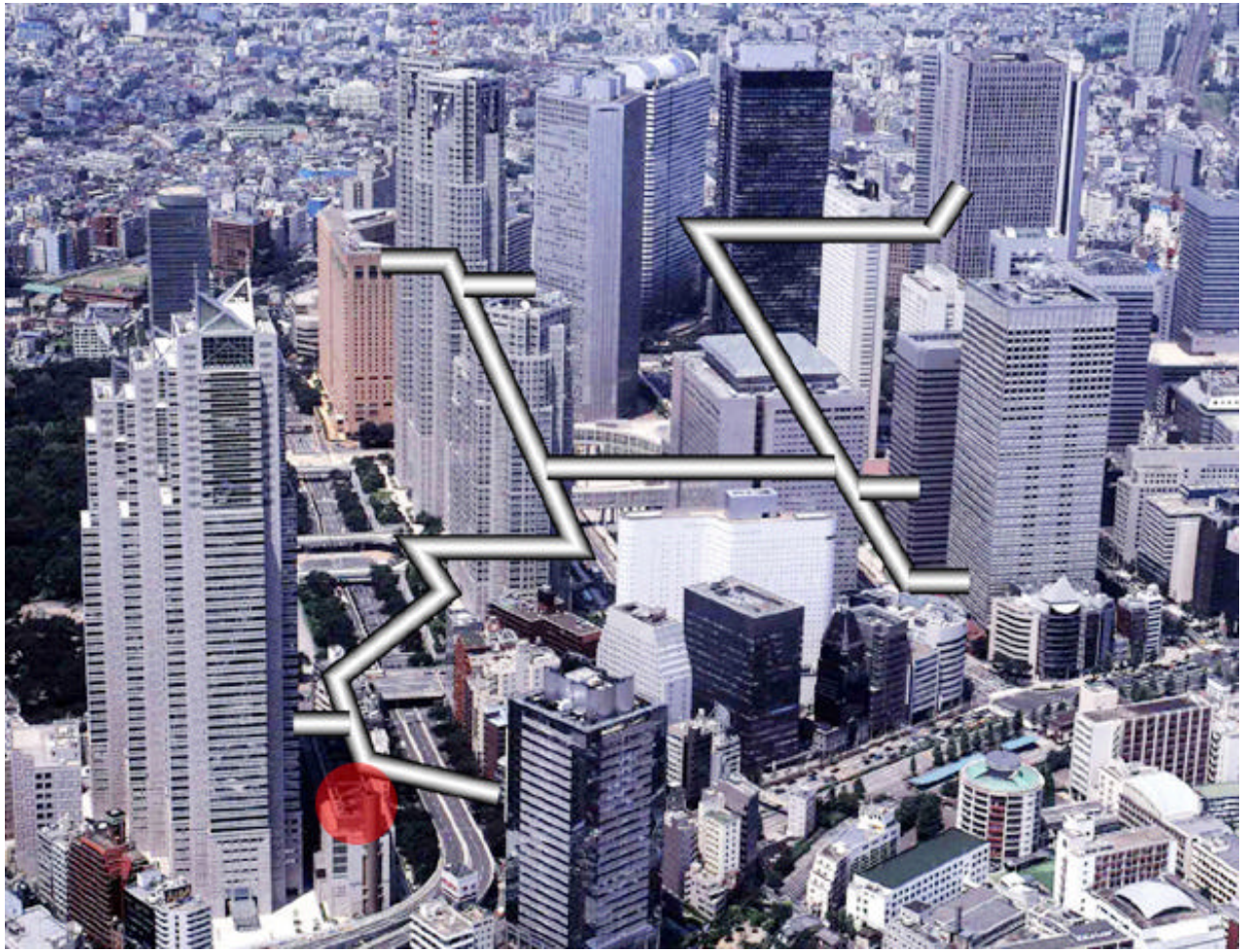
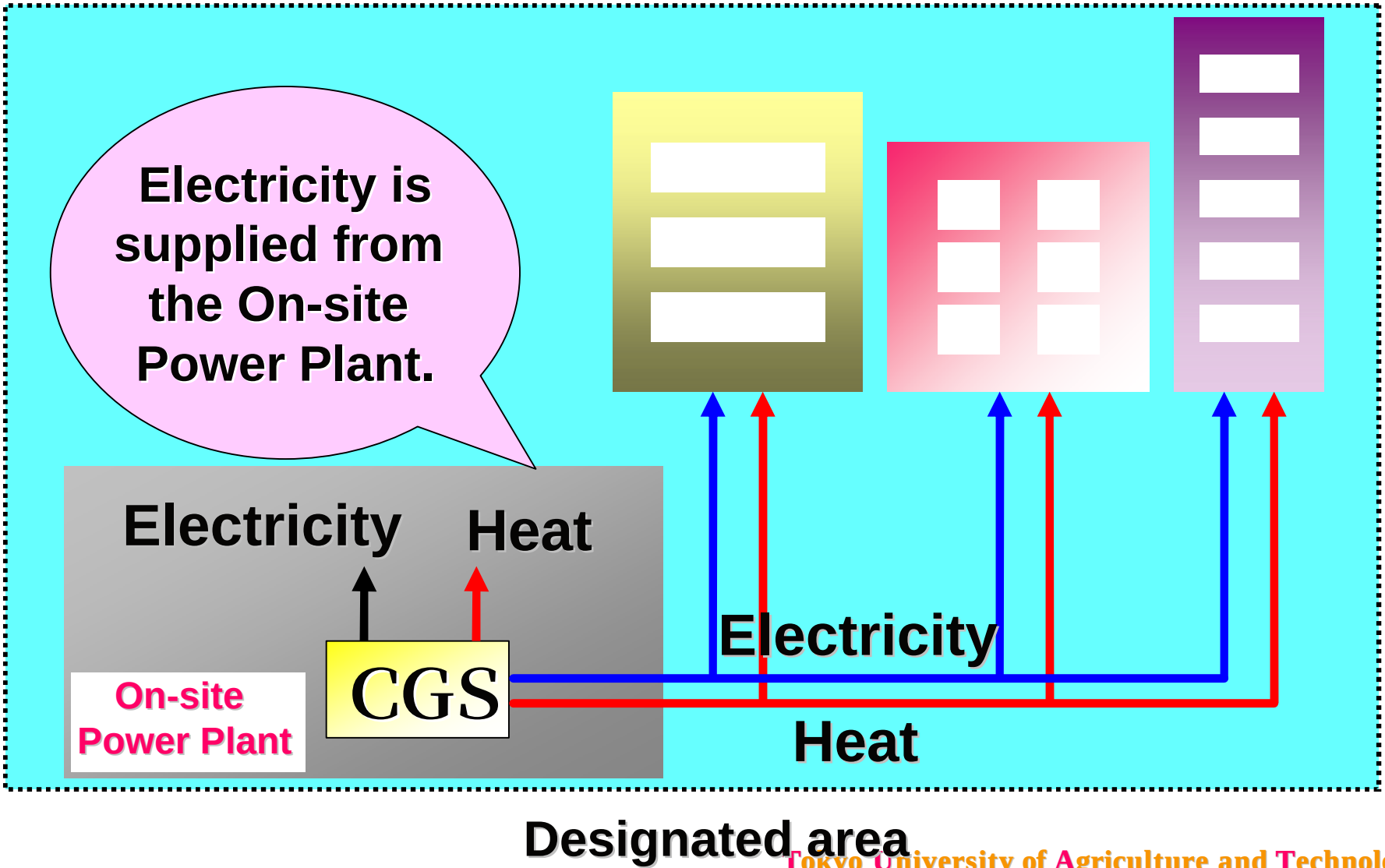
District heating and cooling



SHINJUKU District heating and cooling

Deregulation in the electricity business

Specified Electrical Power Supply Business



Specified Electrical Power Supply Business

	Established	Capacity	Fuel
Amagasaki Utility Services Co.,Ltd	1998.7	12,600kW	Natural Gas
Suwa Energy Services Co.,Ltd	1997.6	3,122kW	LPG
East Japan Railway Company	2001.9	198,400kW	Kerosene
Roppongi Energy Services Co.,Ltd	2001.9	38,660kW	Natural Gas
Sumitomo Cooperative Power	2003.3	1,071kW	Hydro Power

Roppongi Redevelopment Project

Specified Electrical Power Supply Business

gas turbines
6,360kW × 6sets
steam turbine
500kW × 1set

- Area ：12.7 ha
- Total floor area ： 750,000m²

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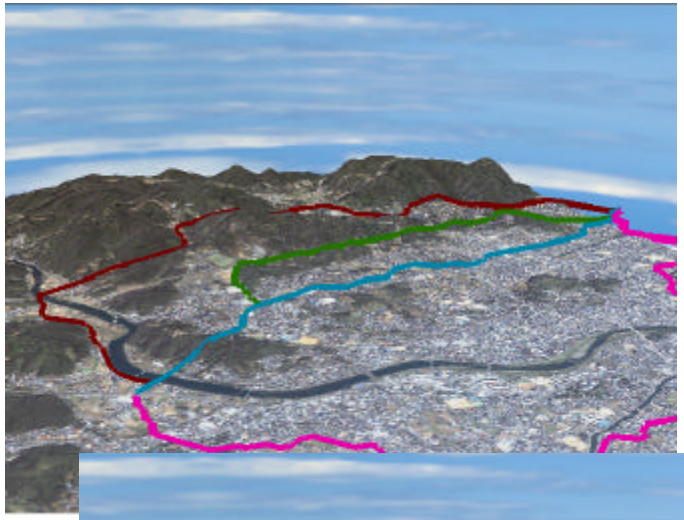
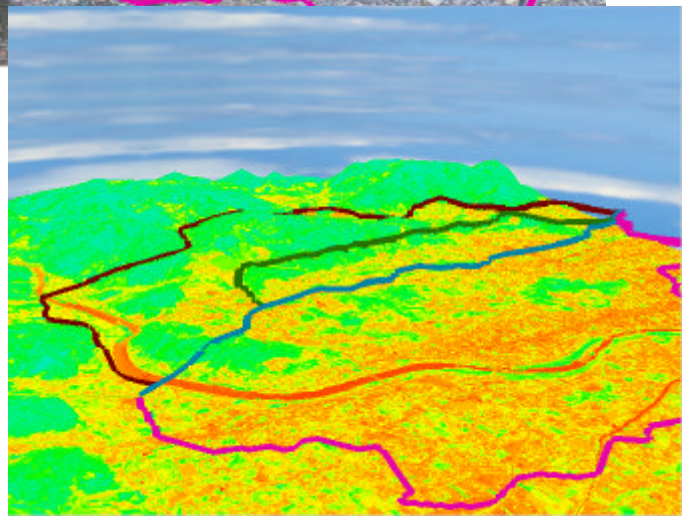
The city simulator

A sustainable city planning tool of resources





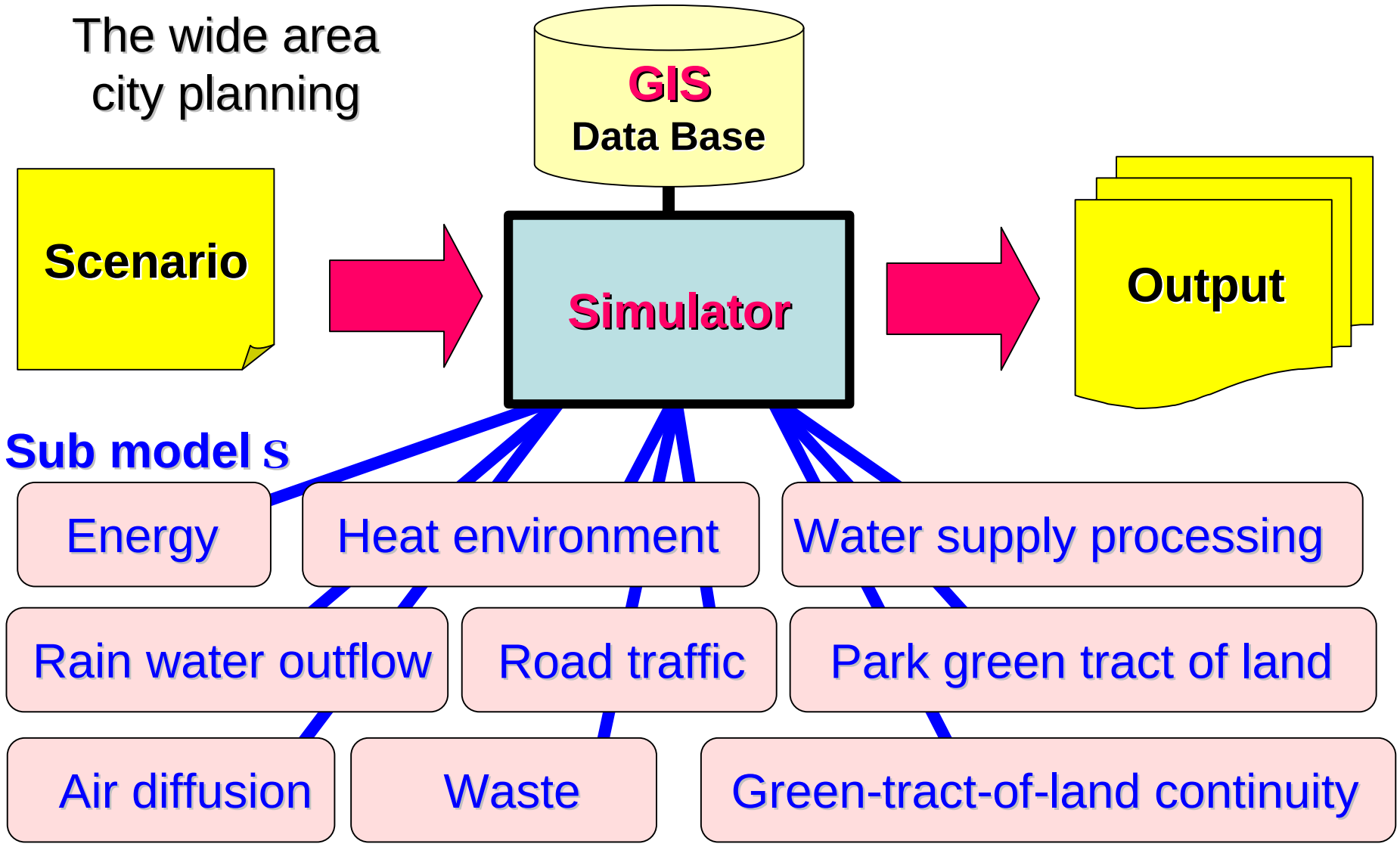
Characteristic

- The object of evaluation ： The wide area level
- Evaluation from various angles
- Utilization of GIS

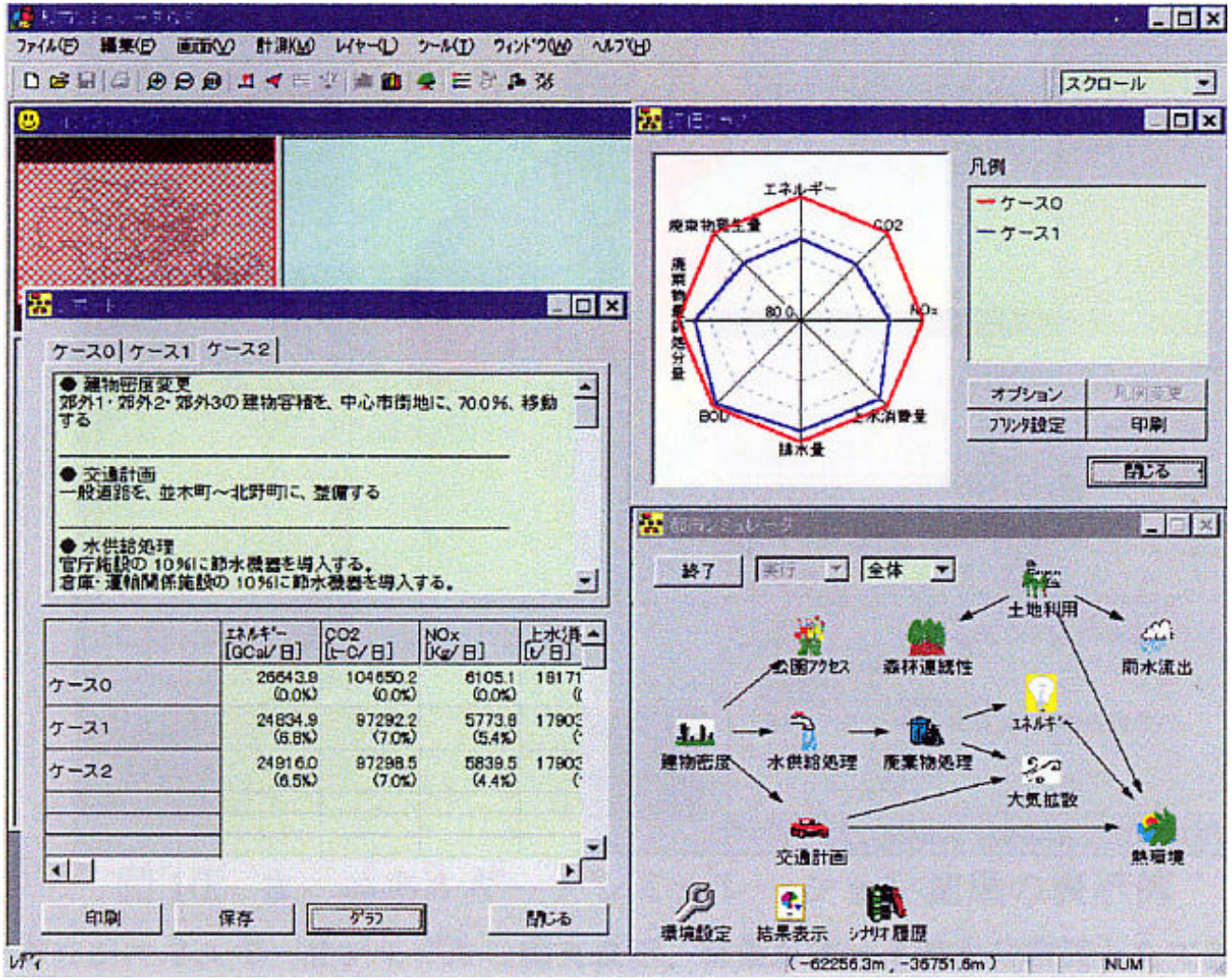
Studies-and-development period

1997～2001

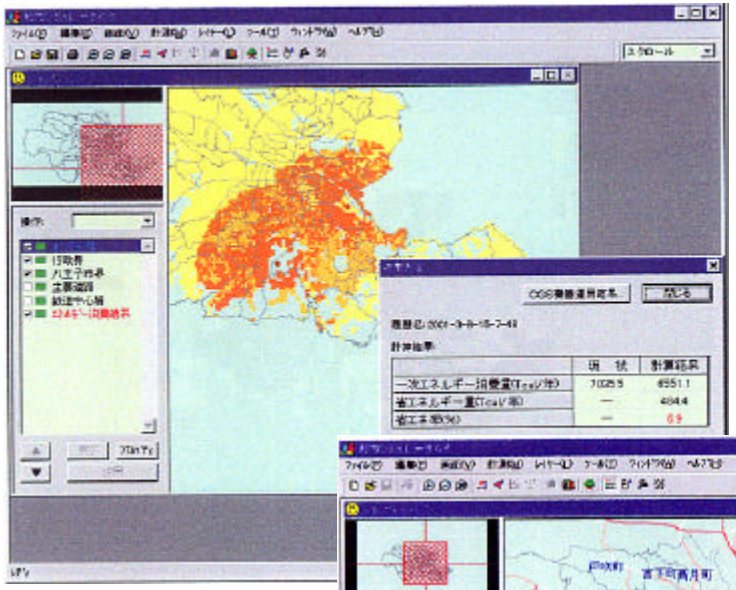
Composition of the simulator



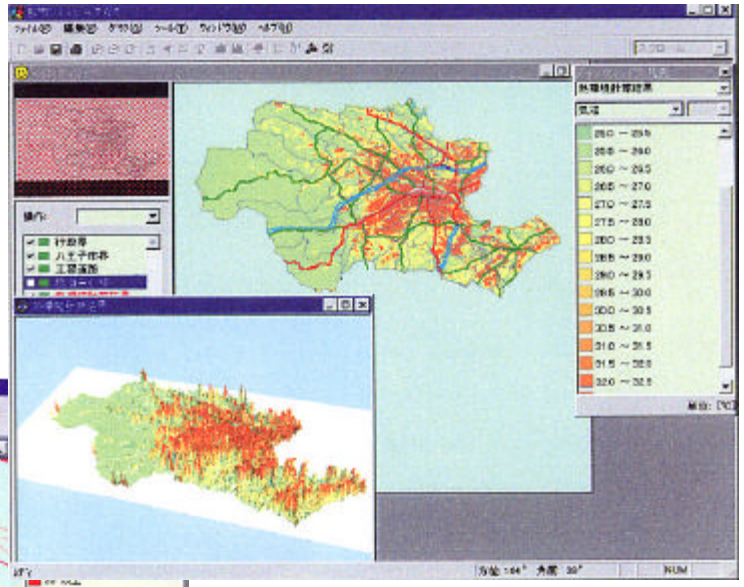
Output screen



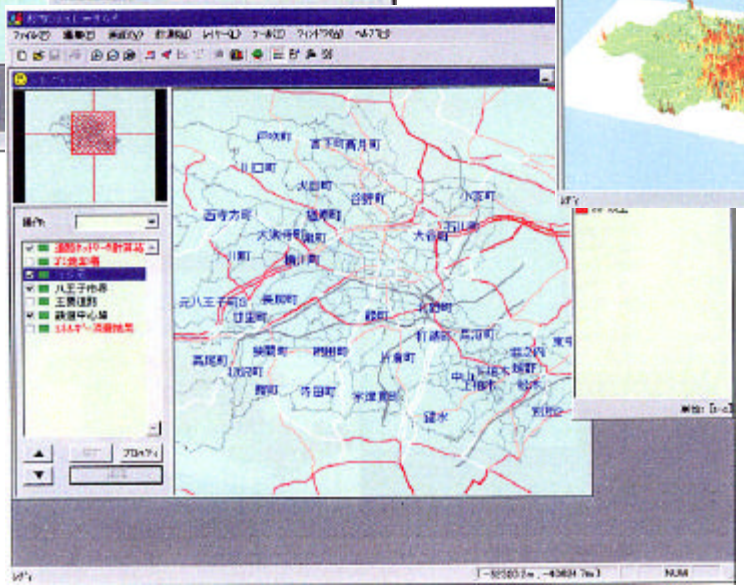
The individual evaluation example



Energy



Heat environment



Road traffic

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C-PLAN

The program which plans and evaluates an area energy system

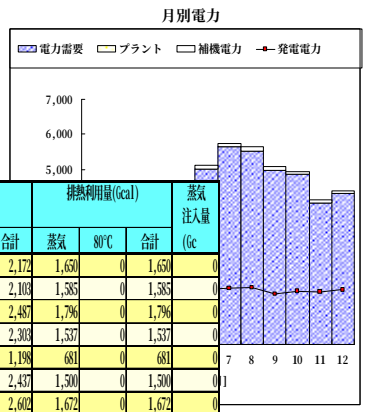
It specializes in a energy system.

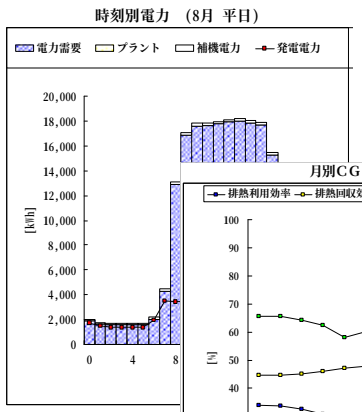
It is possible to carry out the simulation of the energy balance in detail over every year per 1 hour.

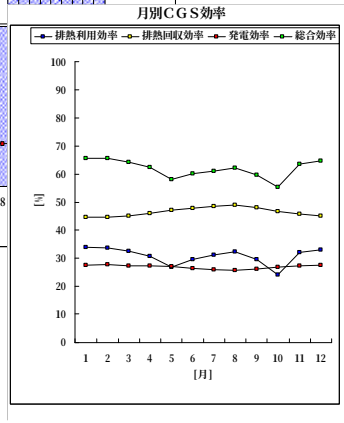
[年間　ビルCGS集計

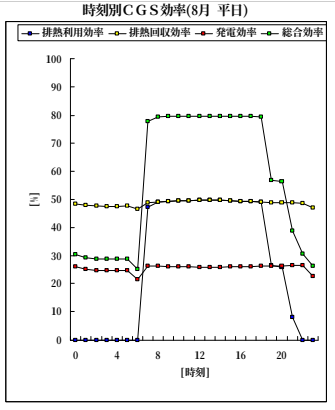
項目	電力負荷 (MWh) 二次側	CGS補機	合計	発電量 (MWh)	買電量 (MWh)	売電量 (MWh)	CGSガス消費量 (m3)	排熱回収量(Gcal) 蒸気	80℃	合計	排熱利用量(Gcal) 蒸気	80℃	合計	蒸気注入量 (Gc
1月	4,004	84	4,088	1,556	2,532	0	490,724	2,172	0	2,172	1,650	0	1,650	0
2月	4,161	79	4,240	1,515	2,725	0	474,953	2,103	0	2,103	1,585	0	1,585	0
3月	4,564	96	4,660	1,754	2,906	0	555,750	2,487	0	2,487	1,796	0	1,796	0
4月	4,424	88	4,512	1,586	2,926	0	503,606	2,303	0	2,303	1,537	0	1,537	0
5月	4,497	45	4,542	798	3,744	0	256,084	1,198	0	1,198	681	0	681	0
6月	5,012	94	5,106	1,563	3,543	0	512,846	2,437	0	2,437	1,500	0	1,500	0
7月	5,639	103	5,742	1,608	4,135	0	539,741	2,602	0	2,602	1,672	0	1,672	0
8月	5,527	105	5,632	1,626	4,006	0	548,017	2,662	0	2,662	1,761	0	1,761	0
9月	4,978	90	5,068	1,434	3,634	0	476,383	2,274	0	2,274	1,400	0	1,400	0
10月	4,850	88	4,937	1,519	3,418	0	489,450	2,273	0	2,273	1,172	0	1,172	0
11月	4,043	84	4,127	1,506	2,621	0	478,484	2,175	0	2,175	1,524	0	1,524	0
12月	4,301	84	4,384	1,561	2,823	0	491,761	2,200	0	2,200	1,609	0	1,609	0
合計	56,000	1,039	57,039	18,026	39,013	0	5,818,001	26,885	0	26,885	17,886	0	17,886	0

※蒸気注入量は蒸気注入GTへの入力分。

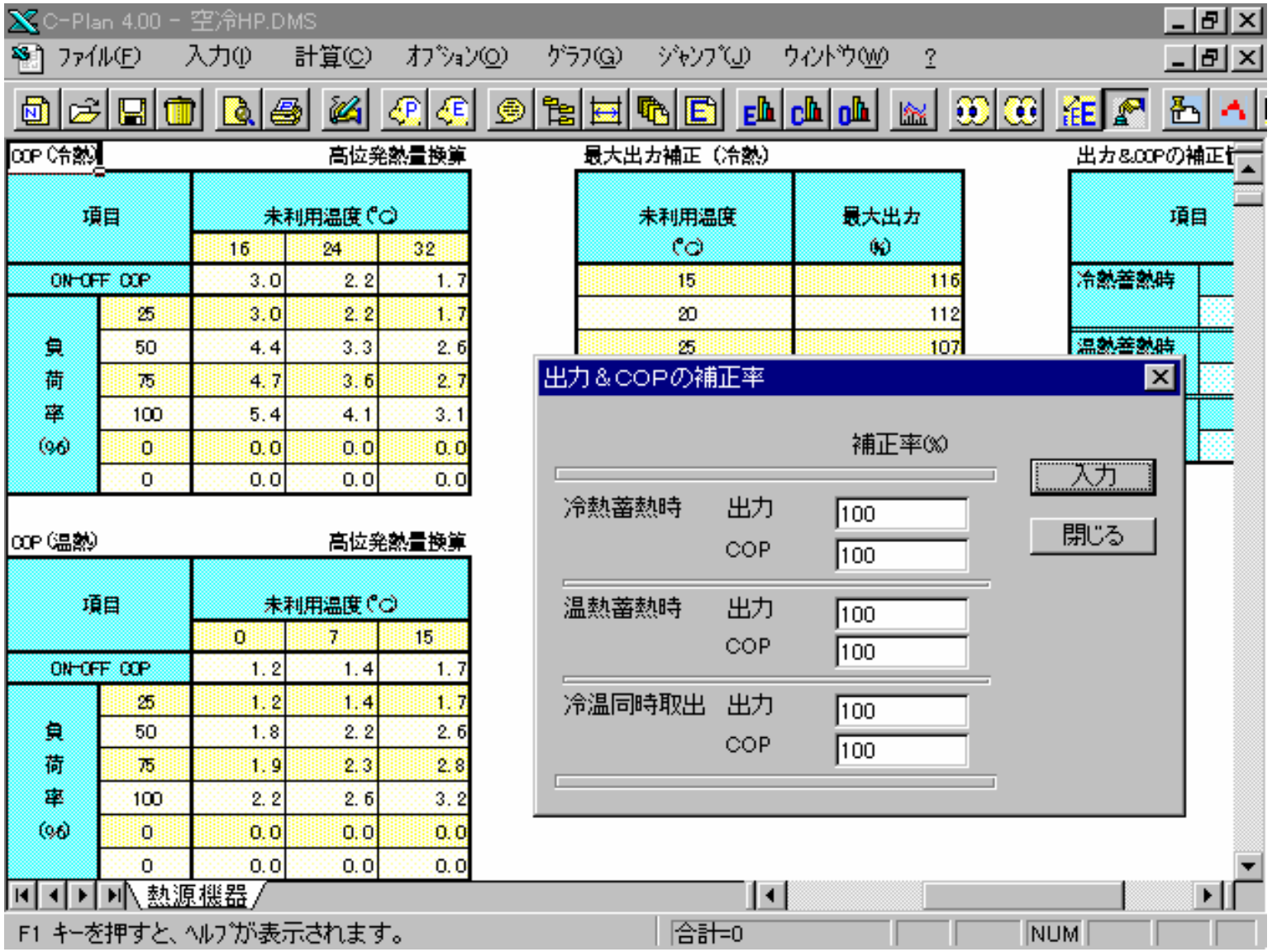








Input screen



The target energy system

- Various electric-type and gas-type heat source apparatus （17 kinds）
- Cogeneration system

  （It corresponds also to the installation to a consumer site.）
- Thermal storage system

  （Hot water・Chilled water・Ice）
- Unused energy practical use system

Other functions

- A detailed calculation function
  - ✧Open air temperature compensation
  - ✧Partial load efficiency
  - ✧Ventilation in a machinery room, air-conditioning
- Abundant built-in data
  - ✧Building load data （Six kinds of building uses）
  - ✧Apparatus data （20 or more kinds）
  - ✧Various unused energy data
  - ✧Outside temperature data

The flow of calculation

Load creation

It calculates automatically from a building use and total floor area.

Energy calculation

24 hours ×12 months (Weekday ・Holiday)

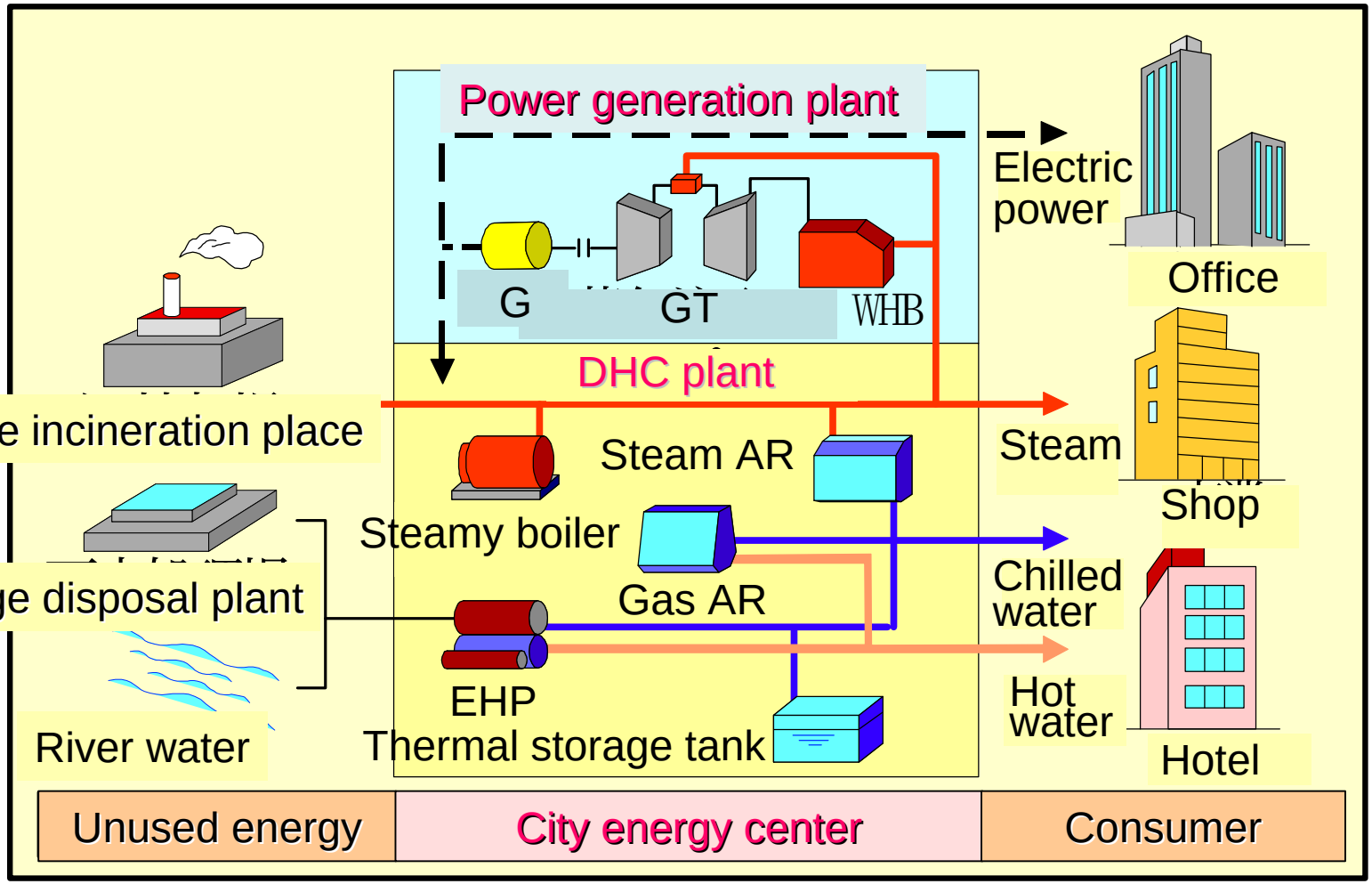
Economical efficiency, ecological balance calculation

The table of the newest energy cost is supported

Graph output

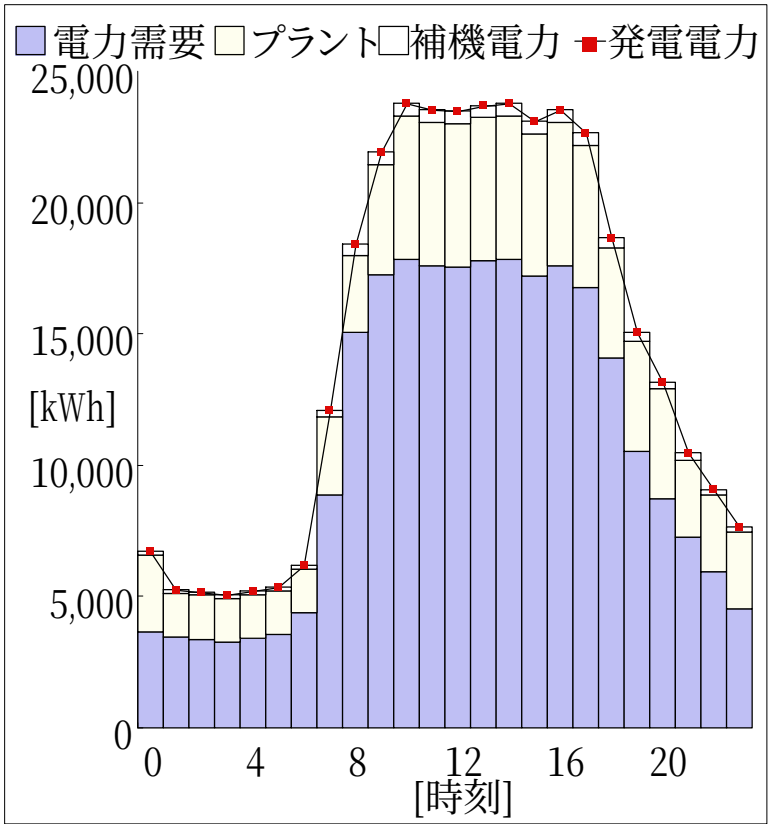
12 kinds of graph is outputted arbitrarily.

The example of a system configurator

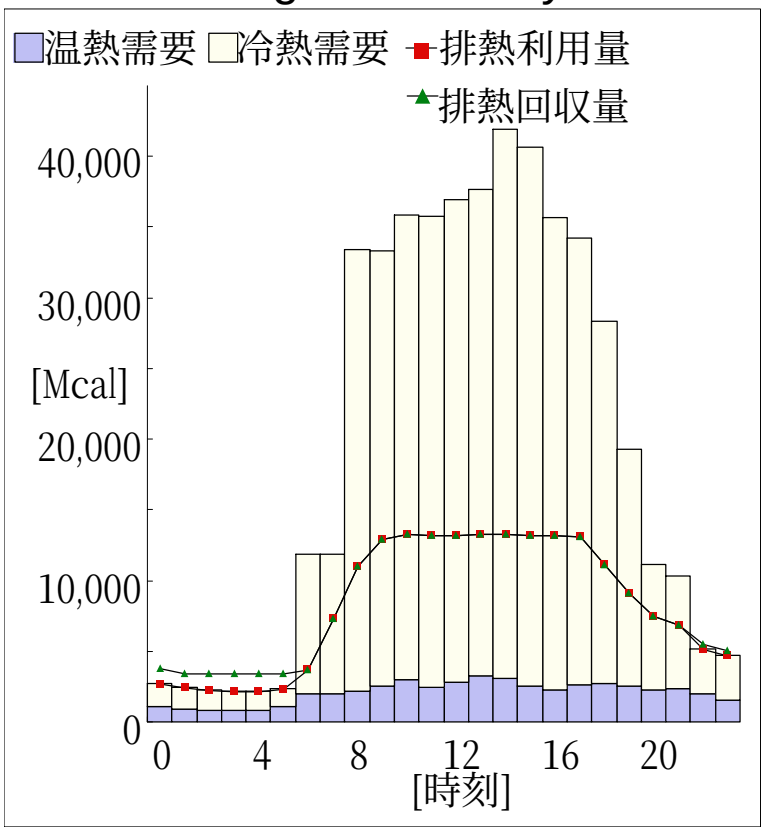


The example of graph outputs

Electric power according to time
(August weekday)



Waste heat according to time
(August weekday)



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The subject of local energy system evaluation

- It is required to be not macroscopic evaluation but a simulation with the detailed level which can be used for a practical regional plan.
- The tool needs to be able to examine flexible systems, such as a micro grid.
- The tool needs to utilize the base data of an area effectively. （For example, it is the utilization of GIS.）
- The tool needs to be able to perform many-sided evaluation besides energy.
  - Heat environmental (heat island)
  - Energy security

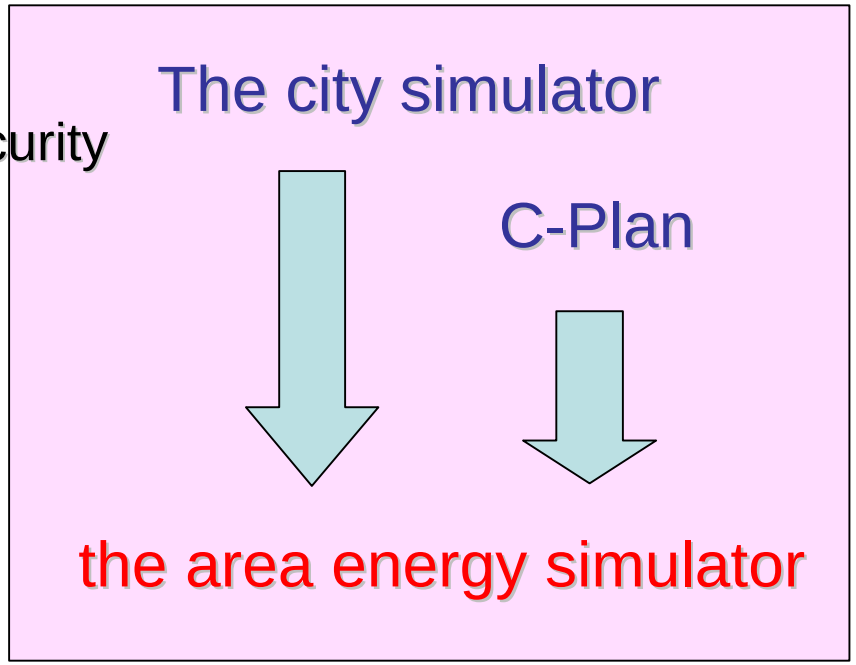
Development of the area energy simulator

Evaluation criteria

Energy, Heat environment, Energy security

A local area energy system

Cogeneration
Renewable energy
(sunlight, wind force ...)
Thermal storage system
Unused energy
Micro grid



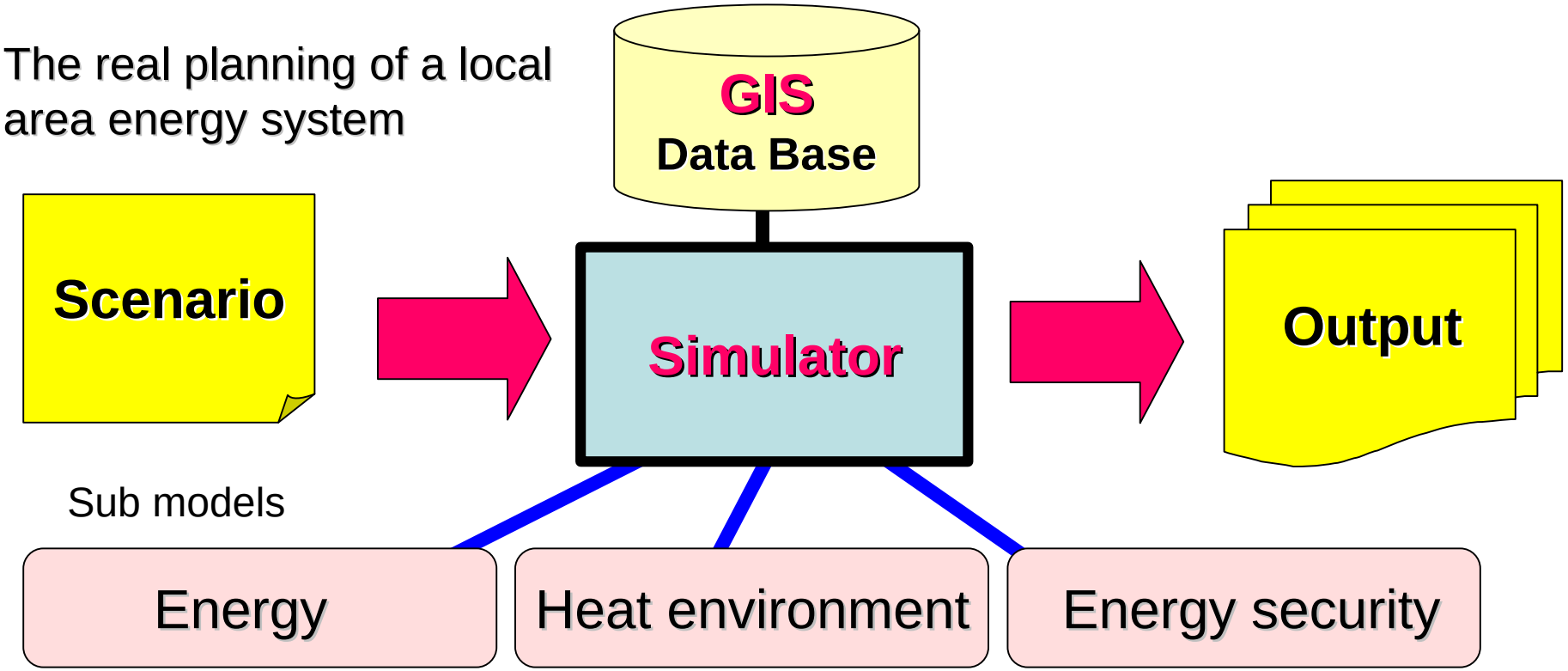
Development period ：2003～2005

Research-and-development organization

Tokyo University of Agriculture and Technology
Yokohama National University
National Institute of Advanced Industrial Science and Technology

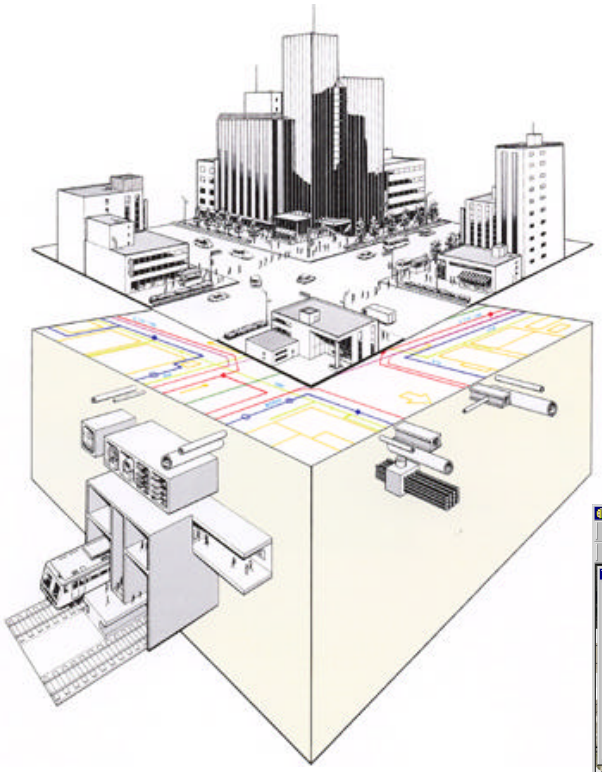
Composition of the simulator

The real planning of a local area energy system



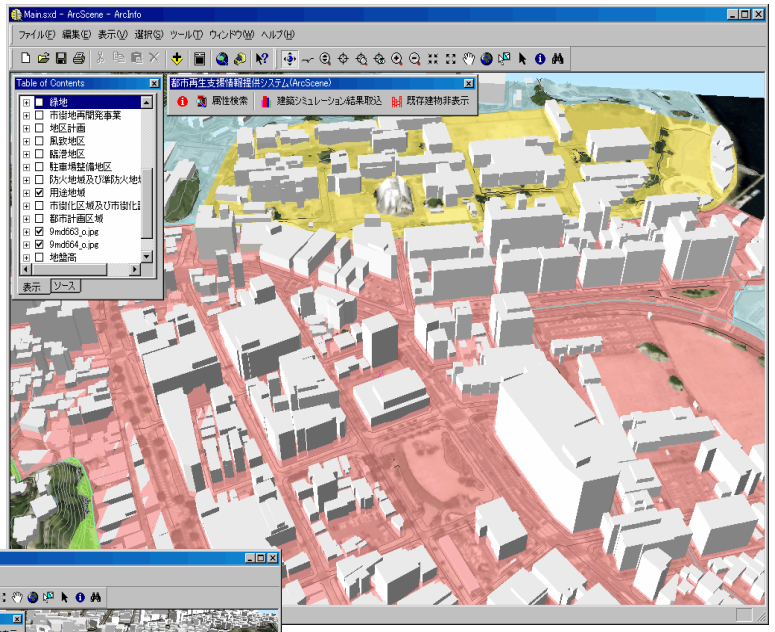
An annual detailed simulation
Introductory evaluation of a micro grid
The introductory plan of renewable energy

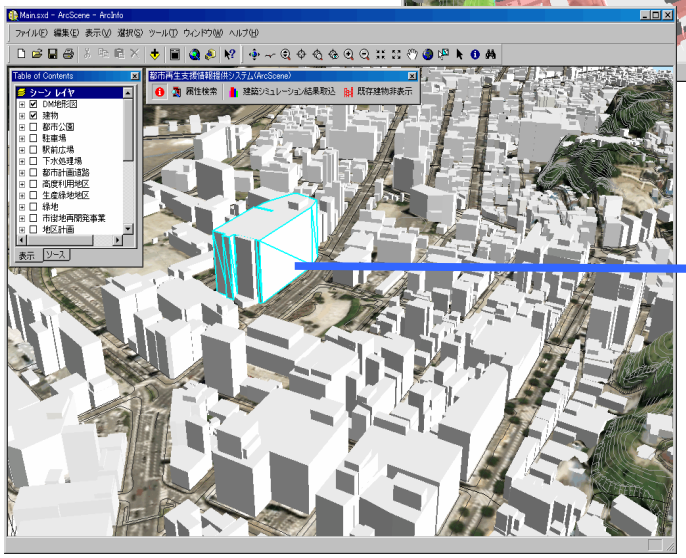
Maintenance of the city infrastructure data using GIS

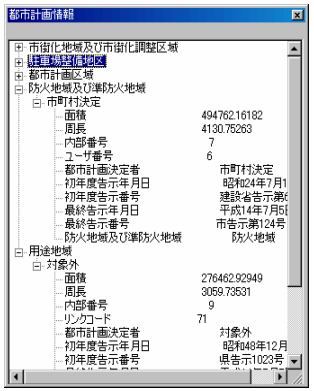


City infrastructure

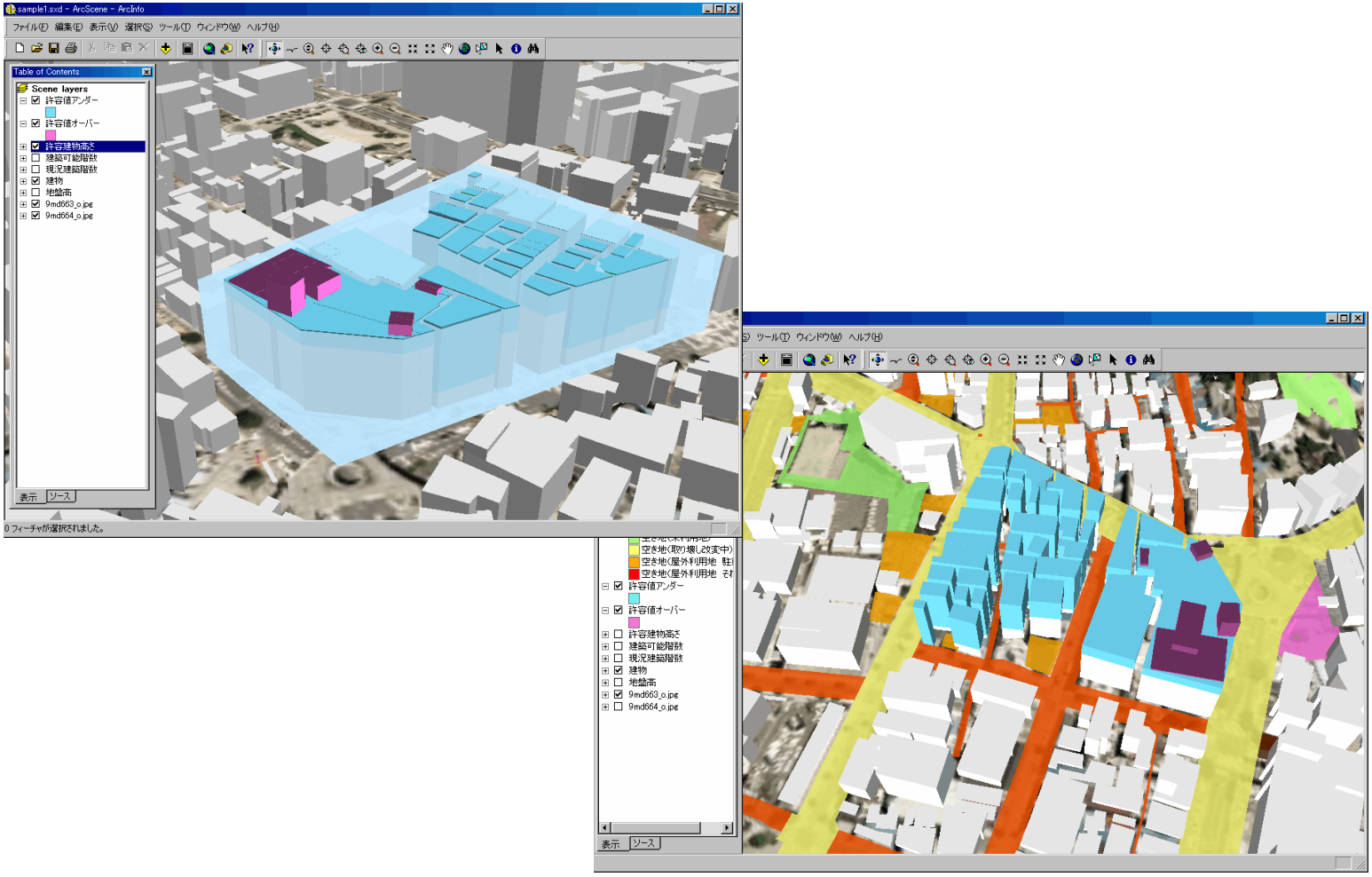
GIS data



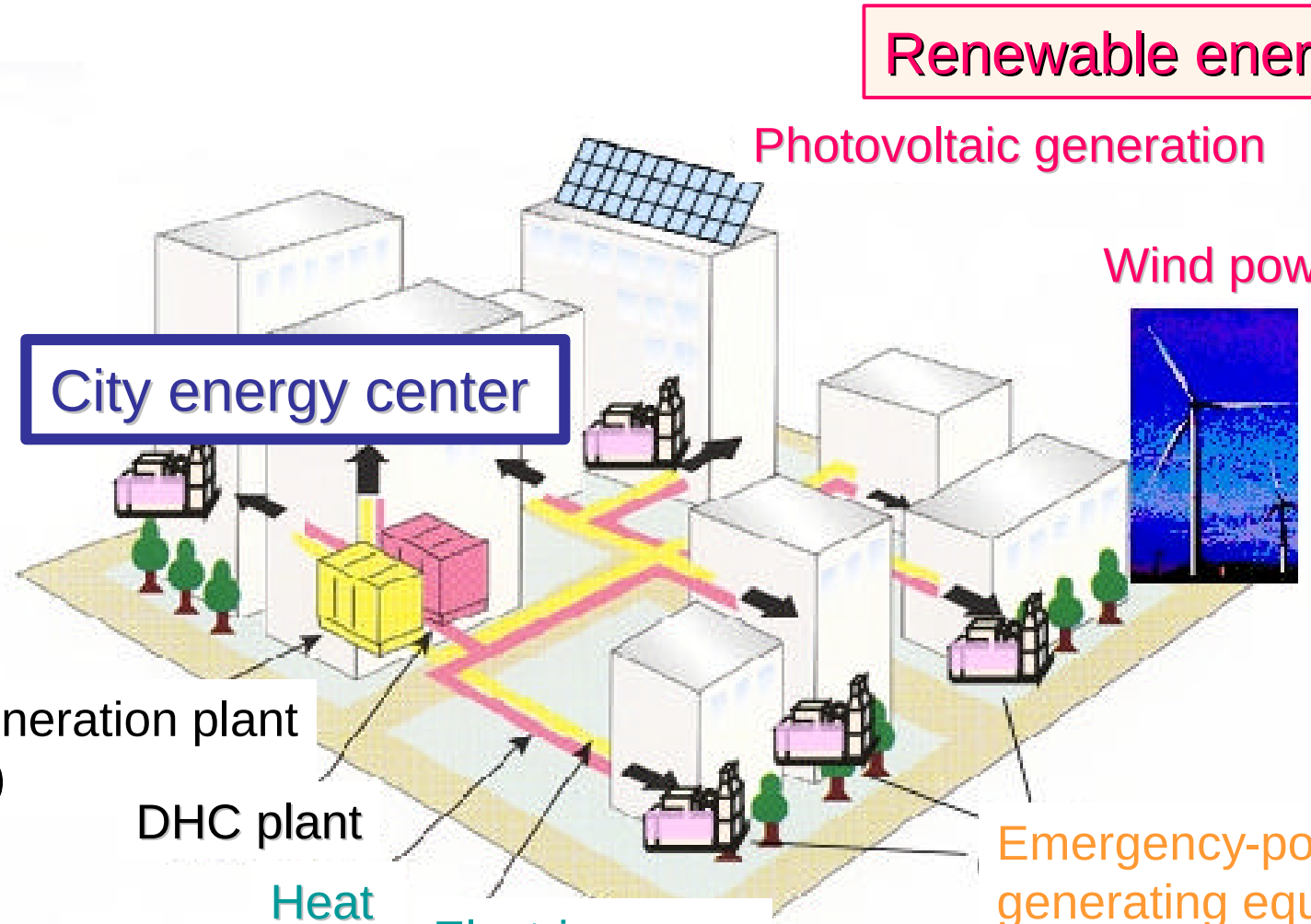




Imagining of a plan area



Local area energy system image



The effect expected

1. Promotion of the energy saving and CO2 further reduction of the commercial and transportation sector in a city
2. Support for optimization of the regional development project which a local government and a developer perform
3. Effect estimation (the energy, ecological balance, and economical efficiency) and visual evaluation of a measure scenario
4. Support for a local energy service business (C-ESCO) or an energy management service business (EMS)
5. Activation of utilizing a geographic information system


Thank you for your attention.